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Comment on "Thermoinduced magnetization in nanoparticles of antiferromagnetic materials" - Morup and Frandsen reply

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Mørup and Frandsen Reply: In their Comment [1], MacDonald and Canali claim that the magnetization of nanoparticles of antiferromagnetic materials cannot increase with increasing temperature as described in our Letter [2]. They argue that there are two equivalent degenerate spin-precession modes in an antiferromagnet with opposite magnetic moments, and the net magnetic moment therefore is zero.

As we have pointed out [2], the average value of the thermoinduced magnetic moment of an antiferromagnetic particle is zero in the absence of an applied magnetic field. However, MacDonald and Canali seem to have failed to notice that Eq. (4) in our Letter [2] gives an expression for the average of the *numerical value* of the magnetic moment (which, of course, is identical to the average value of the $+$ mode). Equation (1) in their Comment [1] gives the net magnetic moment in the absence of an applied magnetic field. If a magnetic field is applied, the degeneracy of the $+$ and $-$ modes is lifted and the populations will differ, resulting in a nonzero contribution to the magnetization. For $S_A = S_B$ one obtains the expression for the initial susceptibility given by Eq. (5) in our Letter.

It has been realized in earlier studies that the uniform mode in bulk antiferromagnetic materials has an associated magnetic moment. If this were not the case one would not be able to excite the uniform mode by an ac field; i.e., this magnetic moment is a prerequisite for antiferromagnetic resonance experiments. In our Letter we point out that the uniform mode, which can be excited by an ac field in bulk antiferromagnetic materials, can be thermally excited in nanoparticles, and in an applied magnetic field it gives rise to the thermoinduced magnetization in the nanoparticles.

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[1] A. H. MacDonald and C. M. Canali, preceding Comment, Phys. Rev. Lett. **94**, 089701 (2005).
[2] S. Mørup and C. Frandsen, Phys. Rev. Lett. **92**, 217201 (2004).

